Thermal Protection System Materials (TPSM): 3D MAT Project

Game Changing Development Program | Space Technology Mission Directorate (STMD)

ANTICIPATED BENEFITS

To NASA funded missions:

3D MAT provides an innovative, robust material solution that will have the combined structural strength and thermal insulation properties for Orion compression pad design needed for MPCV missions. These missions are more demanding than the Low Earth Orbit (LEO) missions, where the use of 2-dimensional laminate materials along with a metal insert are deemed adequate but cannot be extended for Lunar return missions.

DETAILED DESCRIPTION

The 3D MAT Project seeks to design and develop a game changing Woven Thermal Protection System (TPS) technology tailored to meet the needs of the Orion Multi-Purpose Crew Vehicle (MPCV) compression pad design for lunar return EM-1 mission and beyond. The technology being developed is a multifunctional ablative thermal protection system material that is capable of meeting the structural and thermal requirements for the MPCV Orion EM-1 mission and beyond. The Orion compression pads serve as the interface between the Crew Module and Service Module. The Orion compression pads must carry the structural loads generated during launch, space operations and pyroshock separation of the two modules, and then must serve as an ablative TPS withstanding the high heating of Earth re-entry. Current materials do not meet all of the requirements due to either insufficient mechanical strength or limited ability to manufacture to the required dimensions. The goal of 3D MAT is to deliver a prototype compression pad material at Technology Readiness Level (TRL) of 4 in 2014 to enable Orion's further development and use of the material on the MPCV flight in 2017.

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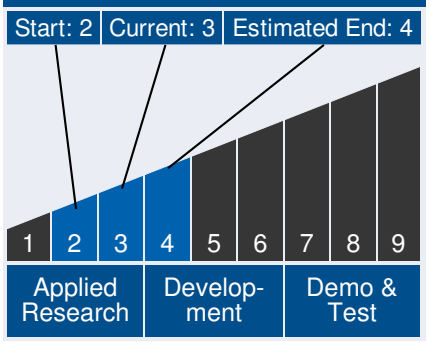
Technology Maturity



Management Team

Program Executive:

- Lanetra Tate

Program Manager:

- Mary Wusk

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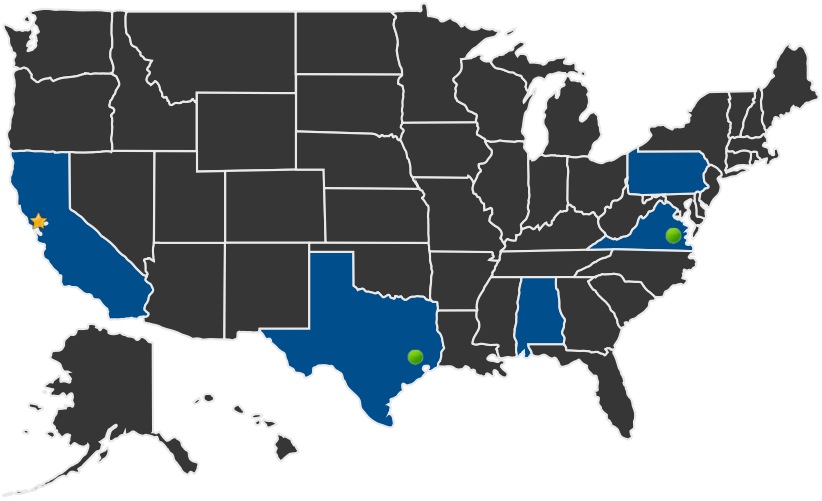
U.S. WORK LOCATIONS AND KEY PARTNERS



U.S. States With Work

Lead Center:
Ames Research Center

Supporting Centers:

- Johnson Space Center
- Langley Research Center

Management Team *(cont.)*

Project Manager:

- Ethiraj Venkatapathy

Principal Investigator:

- Michelle Munk

Co-Investigator:

- Ronald Chinnapongse

Technology Areas

Primary Technology Area:
Thermal Management Systems (TA 14)
└ Thermal Protection Systems (TA 14.3)
└ Ascent/Entry TPS (TA 14.3.1)
└ Rigid Ablative Thermal Protection Systems (TA 14.3.1.1)

DETAILS FOR TECHNOLOGY 1

Technology Title

3D MAT

Technology Description

This technology is categorized as a material for unmanned spaceflight

The goal of 3D MAT is to develop a viable 3D woven material for the MPCV EM-1 mission, demonstrate their manufacturability, scale up of one option to the required Orion compression pad size, and advance the TRL for this application via material property, arc jet (aerothermal), creep and pyroshock testing. 3D MAT is leveraging the efforts of NASA's Space Technology Mission Directorate's investment in Woven TPS to design, manufacture, test, and develop a prototype

material for Orion compression pads. The technology combines the 3D weaving of quartz yarn (preforms) with a resin transfer molding process to develop a robust, multi-functional material architecture capable of meeting both structural and thermal performance needs for lunar return missions and beyond. Driving requirements for the Orion compression pad include: ability to carry compression moment and shear loads, maintain positive margin against a 500 °F bondline temperature (maximum), be manufacturable to approximately 2.75” thickness by 8.75” diameter, function thermally after exposure to the separation bolt pyroshock event, and shall work with the separation push-off springs.

Capabilities Provided

A multifunctional ablative thermal protection system material that is capable of meeting the structural and thermal requirements for the MPCV Orion EM-1 mission and beyond.

Potential Applications

Material souution for MPCV Orion compression pad design.